THE CONNOLLY STANDARD COMPASS FOR CHECKING FIELD COMPASSES AND OBSERVING MAGNETIC DECLINATION.

(From *Publication* N° 210 by E. R. WATTS & SON).

Mr. T. F. CONNOLLY, M. Sc., F. Inst. P., is the designer of an instrument recently put on the market by Messrs. E. R. WATTS & Son, London, for accurately defining the Magnetic North Line.

This instrument known as the *Connolly Standard Compass* is primarily designed as a portable standard for testing magnetic compasses and its main use is not for general field-work but as an easily available check for field-compasses in ordinary use.

In all Surveying Instruments having a magnetic Compass, it is of importance that the magnetic alignment as shown by the needle and the sighting device should be within certain limits of accuracy. What those limits should be, depends upon what kind of work is being done, and also what instrument is being used. With a 2 in. Army Prismatic Compass, an accuracy of ½° would probably be considered sufficient, whilst with the modern telescopic compass of a Theodolite, an accuracy of 10 min., or even 5 min. of arc might be expected.

Practically all such instruments, however, depend upon the maker's calibration which is usually checked from a Standard. Any subsequent alteration, from any cause, is not easy to detect, and cannot be corrected unless a Standard is available.

DESCRIPTION.

The *Connolly Standard Compass* is a self-checking instrument that can be relied upon to give a magnetic alignment to an accuracy of about 1'. It is particularly useful at the Headquarters of Survey Departments, Base Camps and other places where compasses should be checked before being distributed for use in the field.

The instrument consists essentially of a magnetic and an associated sighting systems which are freely swung together on a point and jewel support. The sighting system actually used is a telescope, on the inside walls of which a number of magnets are secured. The telescope, which can be focussed at a distance from 10 ft. to 50 ft., is carried on a cradle with two open "V" supports, the whole being constructed as lightly as possible in aluminium, and weighing in all 9 grammes (1/3 oz.).

The combined telescope and magnetic system is enclosed in a draught-tight box, observations being made through windows at each end. One side of the box is hinged to allow of the telescope being rotated on its longitudinal axis through 180°, which operation is performed with ease and certainty by reason of the fiducial marks on the side of the telescope body. The mean of two observations, after the telescope has oscillated to rest, gives a magnetic alignment free from error, and the diaphragm of the telescope can be set to this mean by the adjusting screws provided.

It is important that the jewel support should be tested for accuracy and freedom of movement before an observation is made, as follows :—

(1) The system should be observed to be swinging quite freely.

(2) On any displacement, after the coming to rest, it should return to the same position.

When not in use, the telescope is removed from its cradle and is carried in spring clips on the inside of the door of the box.

The magnetic telescope and its box are mounted on two different types of base.

In the first type a horizontal circle is fitted, reading by vernier to 1'. The instrument is levelled by three footscrews and a circular bubble. Sights are provided on top of the box. With this instrument, not only the magnetic North line can be indicated, but any point of the compass can easily and accurately be set out.

In the second type no horizontal circle is provided and it will therefore give only the North compass point. Both instruments are conveniently used on a tripod if required.

The weight of the instrument with its case is about 5 3/4 lbs. and the price, with horizontal circle reading to 1', is £ 23. 0. 0, complete in mahogany case. The tripod costs an extra £ 3. 10. 0 and, if a sighting telescope is required instead of open sights, this will add an extra £ 3. 10. 0.

DECLINATION WITH THE CONNOLLY COMPASS.

(Extract from an article by Mr. J. CLENDINNING, B. Sc., published in the *Empire Survey Review*, N° 8, Vol. II, p. 78, London, April 1933).

In the Gold Coast the CONNOLLY Compass, provided with a graduated horizontal plate which can be read to single minutes of arc, has been used as a portable magnetometer for observing the magnetic declination. As such it has given good results and, as its cost is about one-fifth that of the ordinary standard magnetometer, it appears to be a most useful little instrument when reasonably accurate determinations of the magnetic declination at various points and at different times are required.

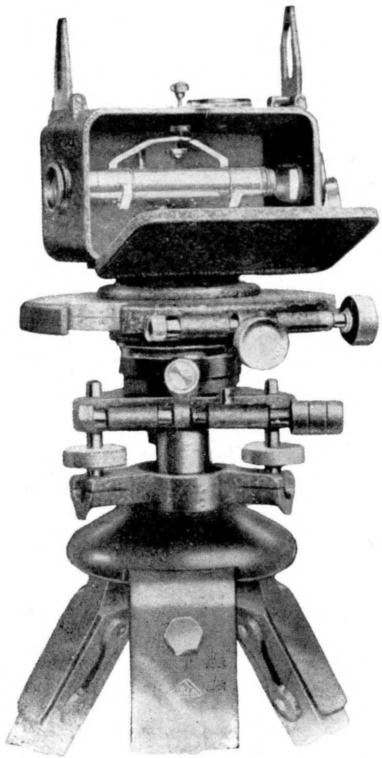
The main great advantage of the instrument is that it does not require any kind of standardization and contains within itself an easy means of eliminating errors due to the magnetic and optical axes not coinciding. In the form used in the Gold Coast the small telescope which forms part of the swinging magnetic system was provided with a graduated diaphragm in which each division on the scale corresponded to 10' of arc. Small angular deviations on either side of the zero of the scale could thus be read directly to 10' of arc, while interpolations could easily be made to single minutes.

The method of using the instrument was to set it up on a line whose true bearing or azimuth was known. The magnetic system was then set swinging freely and, when it had come to rest, a mark consisting of a plumb-bob string was laid out some little distance away so that its image in the telescope was near, but did not necessarily coincide with, the zero mark on the scale in the telescope. The small angular deviation of the image of the mark from the zero of the scale was now read to the nearest minute, and the side of the zero mark, whether right or left, on which the image of the mark appeared, was noted. The small telescope was now taken out of the cradle and rotated through 180° about its longitudinal axis, after which it was replaced and a second reading exactly similar to the first taken. The mean of these two readings gave one value for the true angular deviation between the mark and the magnetic meridian. The next step was to determine the angle between the mark and the line of known bearing. This was done by setting up a mark on this line and then measuring the angle between the two marks on the graduated horizontal arc, the instrument now really being used as a theodolite.

Thus, to take an example, the readings on the scale in two consecutive observations were 1.0 and 2.7, the mark in both cases appearing in the field of the telescope to the right of the zero of the scale. The telescope is inverting; so the mark was really to the left of the scale. Hence, the mean of 1.0 and 2.7 being 1.85, the mark was 1.85 divisions or, since the value of a single division is 10 minutes, 18.5 minutes to the west of the magnetic meridian. The angle between the mark and the line of known bearing was measured and found to be 211°28.5'. But the mark was 18.5' west of the magnetic meridian; hence the magnetic bearing of the line was 211°10.0'. The true bearing was known to be 197°43.1', and thus the observed declination derived from this single series of observations was 13°26.9' W.

The form of instrument used in the Gold Coast had a sighting telescope on top of the box instead of the open sights ordinarily provided. Owing to its construction, the instrument can only be used on fairly level ground. As regards the results obtained, from the series taken at Sekondi on 7th March, 1931, a mean declination of 13°36.7' was obtained with a probable error of ± 0.32', the probable error of a single observation being ± 1.92'.

Another interesting comparison may be obtained from the observation of the magnetic declination at a station at which previous observations had been obtained by a standard



Connolly Standard Compass
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magnetometer. At Accra careful observations of declination were made by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington in 1914, 1919 and 1926. In 1931 the declination was again observed with the CONNOLLY Standard Compass, as the mean of 41 observations spread over 4 days.

The results obtained with the CONNOLLY Standard Compass appear to indicate that occasional errors of anything up to $\pm$ 10′ may occur in a single observation. The probable error of a single observation will not ordinarily exceed $\pm$ 2′ and, if a number of observations are taken, it is unlikely that the probable error of the mean will exceed $\pm$ 0.5′. Further, mean results at "repeat" stations appear to agree tolerably well with results calculated from previous values obtained by magnetometer. Thus, the instrument can be considered to have established its usefulness as a practical and relatively inexpensive declination magnetometer. Most Government Survey Departments are concerned with observations of the magnetic declination and its rate of change and, as the instrument is light and easily carried, it provides an easy means of obtaining better results than can be got by means of any ordinary kind of compass; they are, in fact, comparable in accuracy with those to be obtained with the more elaborate instrument commonly used for this class of work.